

*Supporting Information*

**Single-step cycle pulse operation of the label-free  
electrochemiluminescence immunosensor based on branched  
polypyrrole for carcinoembryonic antigen detection**

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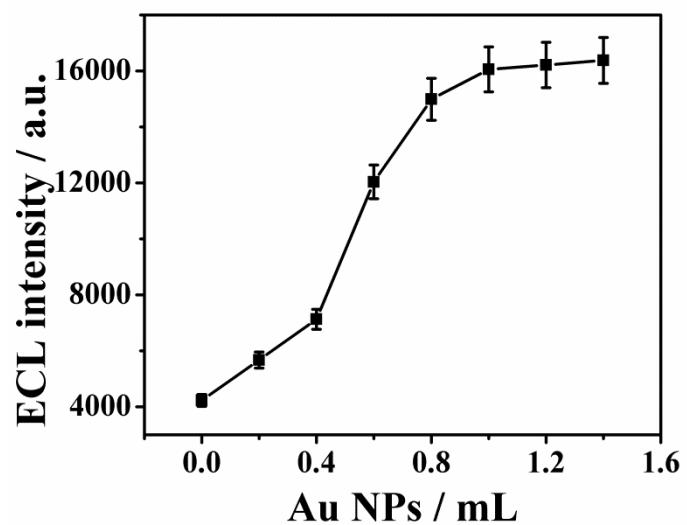


Figure S1. The effect of the amount of Au NPs. Error bar = SD ( $n = 3$ ).

Table S1. A comparison of the performance of the proposed and referenced sensors for CEA.

<b>Method</b>	<b>Material of sensor</b>	<b>Linear range (ng/mL)</b>	<b>Detection limit (pg/mL)</b>	<b>References</b>
Amperometry	Nano-Au/chitosan composite	0.2-120	60	[8]
Voltammetry	Multiarmed star-like Pt nanowires	0.01-60	5	[37]
Potentiometry	Functionalized core/shell Fe <sub>3</sub> O <sub>4</sub> @Ag NPs	1.5-200	500	[38]
Capillary electrophoresis	HRP-aptamer/GO	0.0654-6.54	4.8	[9]
Fluorometry	GO/QD-aptamer	0.257-12.9	5	[39]
Electrochemistry	Hyperbranched polyester	0.08-80	2.36	[11]
Electrochemiluminescence	Polypyrrole loaded AuNPs	0.00001-10	0.003	This work

Table S2. The recoveries of CEA determination in human serum samples using the proposed ECL modified electrodes measured in 10 mL CBS (pH 10.4) containing 25 mM H<sub>2</sub>O<sub>2</sub> (n = 5).

Samples (ng/mL)	Addition (ng/mL)	Detection (ng/mL)	Average value (ng/mL)	RSD (%)	Recovery (%)
	1.00	1.42, 1.54, 1.43, 1.47, 1.57	1.49	4.50	97.4
0.530	3.00	3.42, 3.38, 3.57, 3.62, 3.54	3.51	2.73	99.4
	5.00	5.57, 5.65, 5.47, 5.69, 5.51	5.58	1.59	101